Claims

We claim:

1. A method of detecting a position of a metallic object, the method comprising:

(a) exciting a coil with an electrical signal to produce an electromagnetic field enveloping the metallic object;

(b) allowing a frequency of the electrical signal to be at the resonant frequency of the coil as affected by the metallic object;

(c) adjusting a control signal controlling a characteristic of the electrical signal so that the amplitude of oscillation substantially equals a predetermined standard level;

(d) periodically coupling and decoupling a resistive element in parallel with the coil while performing (a) through (c); and

(e) deriving a signal based upon the adjusted control signal during at least a first time period,

wherein the derived signal is indicative of a difference between at least one first value of an intermediate signal functionally related to the adjusted control signal obtained when the resistive element is coupled in parallel with the coil and at least one second value of the intermediate signal obtained when the resistive element is decoupled, and wherein the derived signal is further indicative of the position of the metallic object.

2. The method of claim 1, wherein the derived signal is representative of a resistance differential between a first resistance level occurring when the resistive element is coupled in parallel with the coil and a second resistance level occurring when the resistive element is decoupled from the coil, wherein the resistance differential is indicative of the position of the metallic object.

3. The method of claim 1, wherein (e) includes amplifying the adjusted control signal.

4. The method of claim 1, wherein (b) is performed by an amplifier having positive feedback from the coil.

5. The method of claim 1 wherein (c) is performed using a rectifier receiving the electrical signal from the coil and rectifying the electrical signal synchronously with the phase of the electrical signal.

6. The method of claim 5 wherein (c) is performed by multiplying the electrical signal by itself, and wherein the characteristic controlled by the adjusted control signal is an amplitude of the electrical signal.

7. The method of claim 1, wherein the adjusted control signal has an envelope with a periodicity corresponding to the periodic coupling and decoupling of the resistive element,

wherein an amplitude of the envelope of the adjusted control signal is indicative of the position of the metallic object, and

wherein the envelope is substantially rectangular.

8. The method of claim 1, wherein the difference is scaled.

9. The method of claim 8, further comprising, during a second time, deriving the signal based only upon at least one third value of the intermediate control signal obtained when the resistive element is decoupled.

10. The method of claim 9, further comprising:

comparing at least one second value of the intermediate signal with a threshold level, wherein the deriving of the signal based only upon the at least one third value begins when one of the second values falls below the threshold level.

11. A sensor for detecting a position of a metallic object, the sensor comprising:

a conductive coil;

an oscillator connected to the conductive coil to:

(1) drive the conductive coil with an oscillating current based upon an external control signal;

(2) to receive feedback from the conductive coil and allow a frequency of the oscillating current to vary in accordance with a varying resonant frequency of the conductive coil as affected by the metallic object;

an amplitude control circuit connected to the oscillator to provide the external control signal to adjust the oscillating current;

an additional circuit coupled to the conductive coil, wherein the additional circuit operates to couple and decouple a resistive element in relation to the conductive coil at first and second times, respectively; and

a processing circuit coupled to the amplitude control circuit,

wherein the processing circuit derives an output signal based upon the external control signal, and

wherein the output signal is derived, at least during some periods of operation of the sensor, based upon a difference between a first sample of at least one of the external control signal and an intermediate signal functionally related to the external control signal obtained at the first time and a second sample of at least one of the external control signal and the intermediate signal obtained at the second time.

12. The sensor of claim 11,

wherein the additional circuit includes a switch coupled in series with a resistor, and wherein the switch operates to alternately couple the resistor in parallel with the coil and decouple the resistor from being coupled in parallel with the coil.

13. The sensor of claim 12, further comprising a clock coupled to the switch of the additional circuit so as to periodically open and close the switch.

14. The sensor of claim 13, further comprising first and second sample and hold circuits, wherein the first sample and hold circuit obtains a plurality of primary samples including the first sample at a plurality of primary times when the switch is closed, and the second sample and hold circuit obtains a plurality of secondary samples including the second sample at a plurality of secondary times when the switch is opened.

15. The sensor of claim 14, wherein the first and second sample and hold circuits are coupled to the clock.

16. The sensor of claim 11, further comprising a device that compares the second sample with a threshold level and, if the second sample is below the threshold level, causes the output signal to be derived based upon at least one of the second sample and a plurality of additional samples that are obtained at a plurality of third times when the resistive circuit is decoupled from the coil.

17. The sensor of claim 16 further comprising a multiplexer coupled to the device.

18. The sensor of claim 11, wherein the oscillator is a gain controlled amplifier having an output connected to the coil and configured for positive feedback.

19. A sensor for detecting a position of a metallic object, the sensor comprising:

an antenna circuit capable of transmitting and receiving electromagnetic signals, wherein the antenna circuit further provides an intermediate signal indicative of a characteristic of operation of the antenna circuit;

a secondary circuit capable of periodically adjusting an effective resistance of at least a portion of the antenna circuit; and

a processing circuit capable of determining an output signal indicative of the position of the metallic object based upon the intermediate signal;

wherein the processing circuit determines the output signal at least in part based upon differences that occur in the intermediate signal between first and second times at which the effective resistance is adjusted to first and second levels, respectively.

20. The sensor of claim 19, wherein the processing circuit includes means for determining when the intermediate signal falls below a threshold level.